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**PORTO RICO AGRICULTURAL EXPERIMENT STATION
MAYAGUEZ, P. R.**

**Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE**

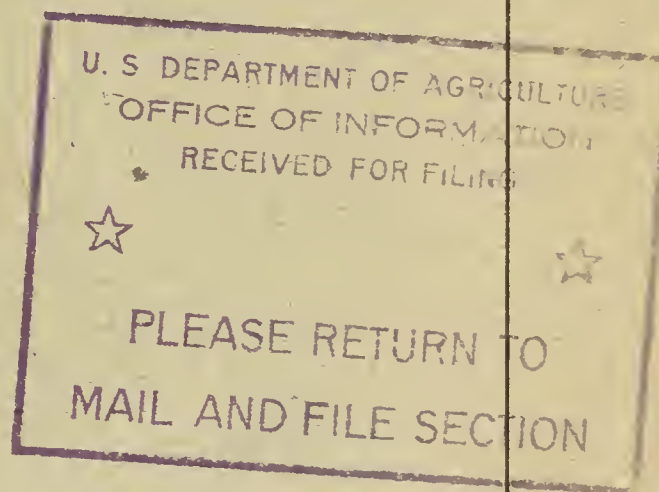
**REPORT OF THE PORTO RICO
AGRICULTURAL EXPERIMENT
STATION**

1923

Issued July, 1924



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1924**



PORTO RICO AGRICULTURAL EXPERIMENT STATION

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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MAYAGUEZ, P. R.

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Washington, D. C.

July, 1924

**REPORT OF THE PORTO RICO AGRICULTURAL
EXPERIMENT STATION, 1923**

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REPORT OF THE AGRONOMIST IN CHARGE

By D. W. MAY

During the fiscal year the work of the station was conducted along the same general lines as in the previous year. Definite progress was made in all activities, and results on the whole were satisfactory.

The mosaic disease of sugar cane, which in past years considerably decreased the yield of sugar, has been brought under control to a considerable degree by growing immune or apparently immune cane varieties, and by roguing the fields of infected stools. In order to overcome losses due to various factors, the station is growing new varieties from seed in the tassel, studying the fertilizer requirements of cane soil, practicing a rational system of rotation by planting velvet beans and *Crotalaria* in the whole field and cowpeas and beans in the young cane, and installing up-to-date machinery to keep down the growing cost of labor.

There has been small increase in the area planted with coffee, notwithstanding the fact that some of the varieties introduced by the station are being successfully grown. The main hope of the coffee industry lies along the line of diversification.

Since the American occupation, fruit growing has made the greatest gains of any of the industries. An indication of the great increase in all lines of production is perhaps best reflected in the external trade of the island which has, in less than 25 years, grown from \$17,000,000 to over \$200,000,000 annually.

RURAL CREDITS

The Federal farm loan act (approved July 17, 1916), enabling farmers to borrow money on farm-mortgage security at a rate of interest not exceeding 6 per cent, has been extended to cover Porto Rico. Loans of the character authorized by this act are assisting many of the farmers to clear off old debts on which they have been paying 12 per cent. The latter rate, while legal on the island, is disastrous for the farming industry, more especially since notarial fees, the cost of registration, and the annual tax on the mortgaged property must be paid in connection with it.

REFORESTATION

In order to provide the forests for water conservation and other purposes, the station has planted approximately 10,000 mahogany trees (*Swietenia macrophylla*) on the 200-acre tract on the mountain above Mayaguez. The trees are making good growth, varying with the type and quality of the soil. Other trees doing well include camphor, mango, and avocado. Leguminous nurse trees, such as the cojoba (*Copaifera hymenæifolia*) and dwarf bucare (*Erythrina corallodendron*), are being planted in the more sterile places. Dwarf bucare grows readily from cuttings, affords shade for coffee, and serves as a windbreak for citrus and as a support for vanilla. (Pl. I, fig. 1.) Velvet beans should be planted as a cover crop after the bucare is started. Other legumes adapted to forest planting while the trees are young include peas, beans, *Crotalaria*, peanuts, and sweet clover.

ANIMAL INDUSTRY

Cattle.—As a result of the introduction of purebred bulls, the dairy cattle of the island are beginning to show noticeable improvement in capacity and in general conformation. Dairy practices, too, are more in accordance with sanitary requirements than was formerly the case. A new concrete dairy building was erected during the year (Pl. I, fig. 2.) Cattle, when they can be afforded, lend themselves to the permanent development of the country.

During the year, four purebred Guernsey heifers and one bull were added to the station herd, which formerly consisted of native cows crossed with purebred bulls. The cattle tick (*Margaropus annulatus*) has been brought under control sufficiently to permit of the importation of purebred cattle by the general stock farmers, while the successful growing of elephant and Guatemala grasses, and other crops suitable for grazing purposes, would seem to assure an abundance of nutritious feed at all times for the animals. (Pl. II, fig. 1.)

Pigs.—Pigs thrive in Porto Rico, but are employed largely as scavengers. The number of grain and root crops suitable for pig feeds should be increased if pig raising is to become an industry.

Poultry.—Although poultry can be produced at a profit in Porto Rico, both refrigerated fowls and eggs continue to be imported at high prices. The few fowls which are kept on the farms subsist altogether upon the "pickings" about the yards and stables. Poultry

should occupy an important place in the diet of the million and a quarter people on the island and be a means of increasing the revenue of the small farmer.

VEGETABLES

Results of experiments made to determine the adaptability of northern varieties of vegetables to island conditions indicate that, with good seed and proper cultural methods, turnips, tomatoes, kohlrabi, peppers, okra, carrots, and peas can be profitably grown here. (Pl. II, fig. 2.) Pea seed, however, should be planted in inoculated soil, or should be inoculated with the proper bacteria, which can be obtained from the station for the purpose. The crop makes small growth when the soil is not inoculated.

FLOWERS

Mainland flowers doing well at the station include nasturtiums, zinnias, snapdragons, violets, balsam, petunias, phlox, and sweet peas. Only the summer flowering sorts of sweet peas should be planted, as the others do not produce blossoms. When the soil is planted with sweet peas for the first time it should be inoculated with nitrogen-fixing bacteria.

REPORT OF THE ASSISTANT CHEMIST

By J. O. CARRERO

MANAGEMENT OF CANE SOILS

The study of nitrogen economy in cane soils was continued, the first ratoon crop being harvested early in the year. This ratoon sprung from plant cane that had been damaged by a storm in 1921 and some of the stools died as a result. The experiment is being carried out on a fairly rich clay soil which, as the result of having received fair amounts of fertilizer as well as lime in other experiments, failed to give striking results in the first trial. Since nitrogen is apparently the fertilizing element which is the controlling factor in cane production, the plats were given liberal applications of phosphoric acid and potash, the nitrogen being supplied in the form of nitrates, and through the agency of a green-manuring crop. Certain sections were limed, and others were left unlimed to serve as checks. When no nitrogen was used, the unlimed plats yielded one and one-half times as much as did the limed plats, the gains holding regardless of whether green manure was used. When nitrogen was applied, the unlimed plats were still ahead of the limed plats in yield, but the difference between them was small, especially when sodium nitrate was used as the source of nitrogen. In the first ratoon crop, the unlimed plats were in the lead, the yield being more pronounced than was the case in the plant cane crop. Small gains were made by plats of plant cane, and large gains by plats of ratoon cane, following treatment with green manure.

With the addition of nitrogen, the unlimed plats of plant cane gave a slightly higher yield than did the limed plats, regardless of

whether green manure, sodium nitrate, or ammonium sulphate was used. In the case of ratoon cane, the same differences, though far greater than for plant cane, were observed in favor of the unlimed plats. A comparison of the plats showed that nitrogen produced a greater gain on the limed than on the unlimed plats.

Apparently lime considerably depressed the effect of the phosphoric acid used on the limed plats, since the increase in yield of the nitrogen plats over those receiving no nitrogen was not sufficiently large to overcome the gain made by plats to which soluble phosphates and nitrogen were applied in combination. The experiment will be continued for some time to determine the full effect of the different forms of the nitrogenous fertilizers applied, as well as the residues, on nitrogen utilization. Data will be kept regarding the fertilizing elements used by the crop, the amount returned to the soil in the trash, the ash burned in the form of bagasse, and the quantity in the cane juice.

STUDY OF SULFOFICATION OF PORTO RICAN SOILS

The various sulfofication experiments being carried on are arousing considerable interest. Especially is this true of the experiments in which raw phosphate is being converted into soluble form by sulfofying bacteria. The numerous caves of the island contain tons of deposits of bat guano, which is not in an immediately available form owing to its tricalcium phosphate, and in many cases, calcium carbonate, nature. Plans for sulfofication experiments with bat guano are under way to learn whether it can be converted into a readily soluble product.

ANALYTICAL WORK

The greater part of the year was devoted to analytical work on samples of various crops which were grown in connection with rice that became affected with the so-called straighthead disease when treated with excessive applications of nitrogenous fertilizer. Approximately 200 seedling canes, together with cane from the fertilized plats, were analyzed. Soil, fertilizer, and other samples submitted by farmers, were analyzed in every case where the results were thought to be of general agricultural interest.

REPORT OF THE HORTICULTURIST

By T. B. McCLELLAND

LEGUMES

Considerable breeding work was done in connection with the regular varietal experiments with beans. Comparative plantings of 66 rows, each 100 feet long, were made during the latter part of February, which is about as late as beans should be planted if the crop is to be harvested before the heavy rains begin. In 16 of the rows the plantings were from selections that had been studied individually.



FIG. 1.—DWARF BUCARE PLANTED FOR SHADE AND WINDBREAK FOR YOUNG CITRUS TREES

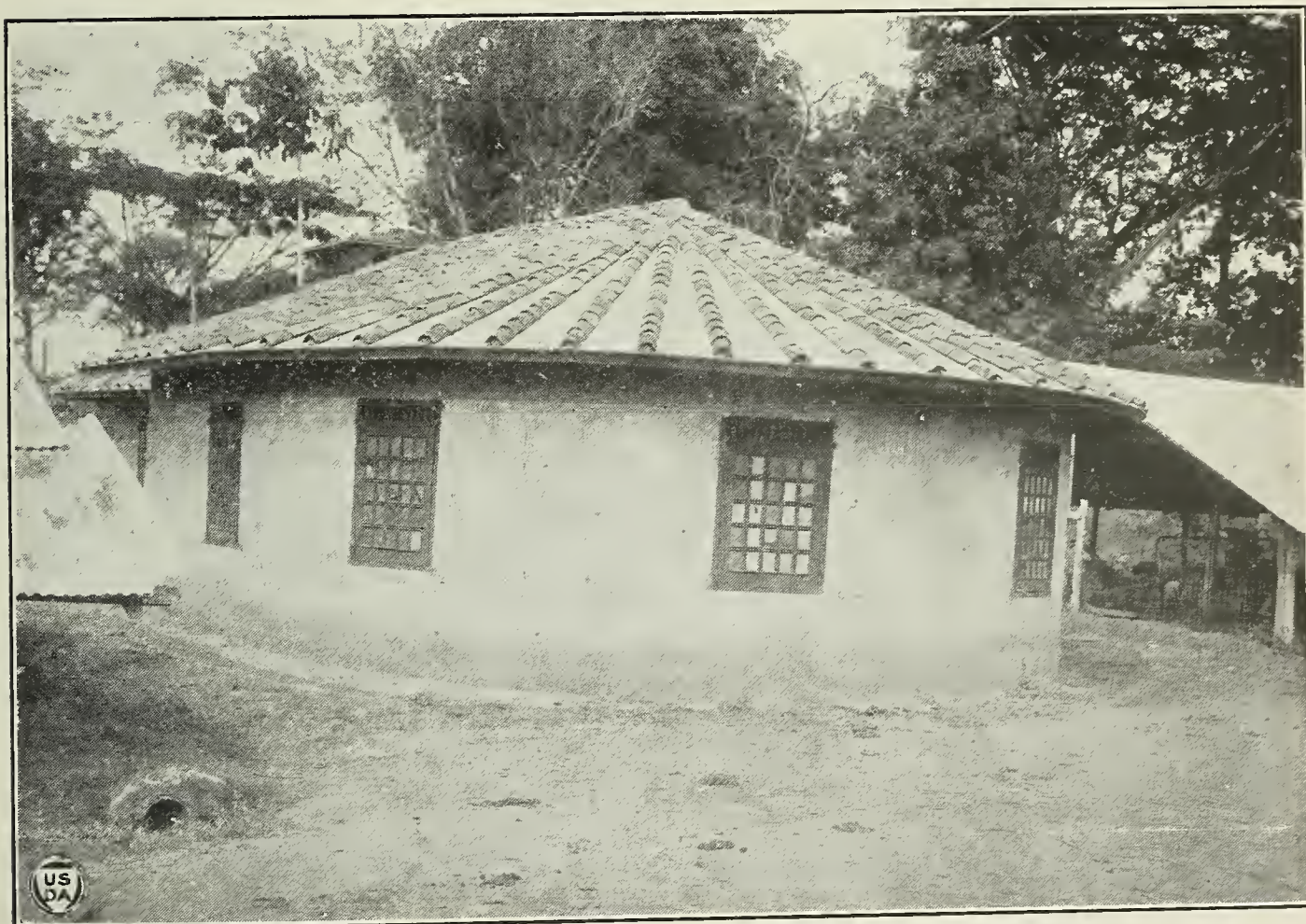


FIG. 2.—NEW DAIRY BUILDING OF CONCRETE AND TILE



FIG. 1.—NAPIER OR ELEPHANT GRASS ON HEAVY CLAY SOIL



FIG. 2.—CHAMPION OF ENGLAND PEAS AT STATION

Drought followed seeding and so retarded germination that the plantings were in varying stages of development in early April, ranging from sprouting seed to plants in blossom. The tropical varieties again demonstrated their superiority over varieties which were imported from the temperate regions, showing that of the number tested they were best able to withstand unfavorable weather conditions. The black Venezuelan yielded in 18 rows on the average 6 pounds 2 ounces of dry beans. This yield was surpassed by 16 rows, comprising 9 of the black Venezuelan, 5 of white strains which were derived from a cross with the black Venezuelan, and 2 of buff beans that were introduced from Brazil. The maximum yield for the black Venezuelan was 9 pounds 10 ounces, and for the white strains 7 pounds 14 ounces. The two rows of Porto Rican red averaged 3 pounds 1 ounce. Since the local market objects to the black color in beans, it is hardly likely that the black Venezuelan, although the heaviest yielder of all varieties so far tested, will ever become established locally. Many white selections from crosses with the black Venezuelan are being tested, and it is thought that there are some valuable strains among them.

A variety having mottled seed coat and fleshy pods was received from Manchuria (China) during the year. So far it is proving one of the most vigorous and productive of the sorts introduced from temperate regions.

Cover crops were again limited to two genera, *Crotalaria* spp. and *Tephrosia candida*. Of the species of *Crotalaria*, *C. juncea* and *C. striata* (large-leaved form), and a variety known at the station as No. .04277, attained a height of 125, 90, and 70 inches, respectively, at four months from seed. The small-leaved form of *C. striata* was little more than half as high as the large-leaved form, and *C. usaramaensis*, *C. incana*, and *C. sericea* were intermediate in height. *C. sagittalis* and *C. retusa* each reached a height of about 25 inches. Due to their small growth, these species are not as desirable for cover crops as are some of the other sorts. When cut 145 days after planting, sections of *C. juncea* and *C. striata* gave a fresh weight per acre of 18.1 and a little less than 16.8 tons, respectively. (Pl. III, fig. 1.) After the plants were thoroughly sun dried, the weights were reduced to 6.1 and 4.2 tons, respectively. Of the several species grown, *C. juncea* gave the most satisfaction as a cover crop, making vigorous and rapid growth, and smothering out encroaching weeds. *C. juncea*, *C. sericea*, and *C. usaramaensis* are all well worth growing as ornamentals.

A study of the photoperiodism of *T. candida* showed that a range of 2.2 hours in local day length is sufficient to determine the blossoming season and modify decidedly the growth of the plant. The investigation will be reported upon later.

MISCELLANEOUS INTRODUCTIONS

Hibiscus.—Although many varieties of ornamental hibiscus grow in Porto Rico, their number is small compared with the kinds found growing in some other parts of the Tropics. Considerable interest is being shown in the growing of this plant as a hedge and for ornamental purposes. Cuttings of some of the beautiful varieties have been introduced from Hawaii and elsewhere and crossed with the widely distributed native sorts. At this writing (June 30, 1923),

approximately 250 seedlings have been produced as the result of the crosses.

Paraguay tea.—Among other plant introductions which are doing well is Paraguay tea (*Ilex paraguayensis*), which should prove of economic value to Porto Rico (Pl. III, fig. 2).

ROOT CROPS

Sweet potatoes.—In a comparative planting of thirty-eight 50-foot rows, Madeira led in production, yielding 183 pounds 7 ounces of roots. Key West ranked second with a yield of 174 pounds 13 ounces. This production was at the rate of $3\frac{1}{2}$ pounds or more per linear foot of row, or 15 to 16 tons per acre. Their nearest competitor, a local variety, yielded at the rate of less than $2\frac{1}{3}$ pounds, and only 5 other varieties gave a yield of 2 pounds or more per linear foot. Key West is deemed a desirable variety for extensive plantings in this locality since it held first rank for two seasons and was a close second for the third season. The variety has been extensively distributed throughout the island. Its roots are of good marketable size, medium to large, and more or less oval in shape, while the flesh of the baked potato is yellow, moist, soft, and sweet, and of good quality. Due to their low yields through three years, the varieties Pumpkin, Dooley, Big Stem Jersey, Red Jersey, Early Red Carolina, and Red Brazil (No. 5978), and Improved Big Stem (No. 21403) have been discarded.

Yams.—Plantings were made of 13 varieties of yams, 10 of which were tested to ascertain the effect on them of staking. The staked vines yielded twice as much as the unstaked vines grown on areas of equal size. For three seasons the value of supporting the vines has been clearly demonstrated, staking affecting not only the weight of the total production of each plant but also the size of its tubers.

Yautias and taros.—Varieties of yautia and taro were again planted at distances of 18 by 36 inches and 36 by 36 inches. The close spacing gave a yield 26.7 per cent greater than the wide spacing for the yautias, and 12.5 per cent for the taros, for equal areas planted, the taro yields reversing the order of results obtained last year. Although a spacing 18 by 36 inches may give a slightly greater area yield than does a spacing 36 by 36 inches, it requires twice as much seed, and does not permit of the free use of an animal-drawn cultivator, as is true in the latter case.

COCONUTS

In the fertilizer work with 9-year-old coconut palms, the check plat produced at the rate of only 36 nuts per tree, while the plat to which common salt (sodium chlorid) was applied led with a production of about 69 nuts per tree. The plats which were given ammonium sulphate in combination with either acid phosphate or potash, or with both, produced on the average 60 to 67 nuts per tree, which was considerably in excess of the yield made by the plat receiving a large part of fertilizer in the form of manure and tobacco stems, or by the plat receiving no nitrogen in the fertilizer. Increasing each semiannual application from 5 to 10 pounds failed to cause any increase in yield.

In the two plantations where salt and potash are being tested, the experiments have not progressed sufficiently to permit of the drawing of conclusions.

COFFEE

Experiments conducted during the last 8 years with coffee trees, grown on 40 small plats of heavy clay soil, demonstrate in a striking manner the need of potash as a fertilizer. (Pl. IV, fig. 1.) Of the 10 plats making the best yields in 1922, 2 had received a complete fertilizer; 3, nitrogen and potash; 2, acid phosphate and potash; 2, potash alone; and 1, no fertilizer (check). Nine of these 10 plats had received potash; 5, nitrogen; and 4, acid phosphate. Twenty plats receiving potash singly or in combination made $2\frac{3}{4}$ times as great a yield as did the same number of plats differing in treatment only in that they received no potash.

The difference in efficiency of the nitrogen carriers, ammonium sulphate and sodium nitrate, has been pronounced on coffee growing in clay soil. In a pot experiment 30 containers, each having a capacity of 5 gallons, were filled with clay soil and then planted with 2 seedlings each. The experiment was divided into 3 groups, of which 2 were fertilized and 1 was left to serve as a check. The former 2 groups received ammonium sulphate (8 grams), or sodium nitrate (10 grams), carrying equivalent amounts of nitrogen, at intervals of 6 months. At a little less than 18 months from setting, the trees receiving ammonium sulphate surpassed those receiving sodium nitrate by 26 per cent in height, 103 per cent in number of leaves, 112 per cent in weight of leaves, and 93 per cent in weight of trunk and branches. The trees receiving sodium nitrate differed from the trees receiving no fertilizer by less than 1 per cent in height and by 5 to 16 per cent in the other particulars. In a new test being started on sand, loam, and also on clay, sodium nitrate will be applied monthly as well as semiannually.

For many years the station has been introducing and testing different varieties of coffee. During the year, data were submitted for publication on the characteristics of these varieties, and their performance at the station.¹

REPORT OF THE PLANT BREEDER

By THOMAS BREGGER

GENERAL WORK

During the year breeding work was continued with corn, rice, eggplant, and several leguminous crops, including beans, cowpeas, soy beans, mungo beans, and velvet beans.

Corn.—In an ear-to-row experiment, having for its purpose the isolation of better yielding strains of corn adapted to the region, native varieties of corn were grown at the station and cooperatively at Isabela. At Mayaguez, the mean yield for 106 duplicated rows of ears was 2,546 pounds per acre, with a minimum and maximum yield of 1,832 and 3,291 pounds, respectively, per acre. At Isabela, the mean yield from 89 rows of ears was 2,139 pounds per acre, with a

¹ Porto Rico Sta. Bul. 30, Coffee varieties in Porto Rico, copies of which may be had by addressing the agronomist in charge.

minimum and maximum yield of 968 and 3,668 pounds, respectively, per acre. Remnants of the 5 lowest and 5 highest yielding selections grown at Mayaguez and at Isabela were planted in isolated multiplication plats at Mayaguez during the spring of 1923. Progeny of the best selections of the 1921 rows of ears were grown for further increase and selection.

Second generation plants, the result of crossing northern sweet corn and dent corn with native varieties, were grown, and selections were made from these for further test and observation.

Rice.—Of the 178 different strains of rice which were turned over to the plant breeder in 1920, 42 were continued in replicated 18-foot plats of 3 rows each, and in 18-foot rows 3 feet apart on both upland and lowland soils. Observations were made of the dates of heading and maturing of the rice, and likewise of the prevalence of *Helminthosporium oryzae*. Seed of a variety of rice from Honduras was distributed in limited quantities to planters requesting it, and several plantings were made to enable the station to distribute large quantities in 1923.

Eggplant.—Second generation plants of a cross between the native striped Pompona and New York Improved were grown in the garden during the winter. Practically all the hybrids were purple fruited and of good size. A few bore fruits resembling the native parent in color or skin, but like the New York Improved in size. Seed from several plants was saved for further selection with a view to establishing the type. A few plants were grown on the Mesa farm, and cions from two of the best purple-fruited sorts were grafted on the wild eggplant (*Solanum torvum*) in the hope of establishing a small commercial planting. When in full bearing, over half the plants were destroyed by a wilt, probably due to *Bacterium solanacearum*.

Beans, soy beans, cowpeas, and velvet beans.—Mass and individual selections of these crops were grown for another generation. Data relative to the yield of 10 varieties of cowpeas and 6 varieties of soy beans were obtained from replicated 40-foot plats of five rows each. New Era again took first rank of the cowpeas, and Virginia made the highest yield of the soy beans. Ootootan and Biloxi, both late-maturing varieties of soy beans, made excellent growth and set a large number of pods, but were again attacked by a disease causing practically all of the seed to shrivel in the pods.

Selections of black, gray, and mottled velvet beans, derived from previous introductions, were planted on the poorer upland soils of the station. Inoculated seed of the varieties Osceola, 100-Day Speckled, and Bunch gave very disappointing results when planted on the Mesa, due to the high percentage of iron in the sterile soils.

REPORTS OF THE ASSISTANTS IN PLANT BREEDING AND HORTICULTURE

By W. P. SNYDER and J. A. SALDAÑA

SUGAR CANE

Of the newly introduced varieties of cane, E. K. 28 and an unknown sort from Java seem to be worthy of further trial (Pl. IV, fig. 2). The variety E. K. 28, although showing some symptoms of



FIG. 1.—*CROTALARIA JUNCEA*, LEFT, AND *C. STRIATA*, RIGHT, GROWN AS COVER CROPS

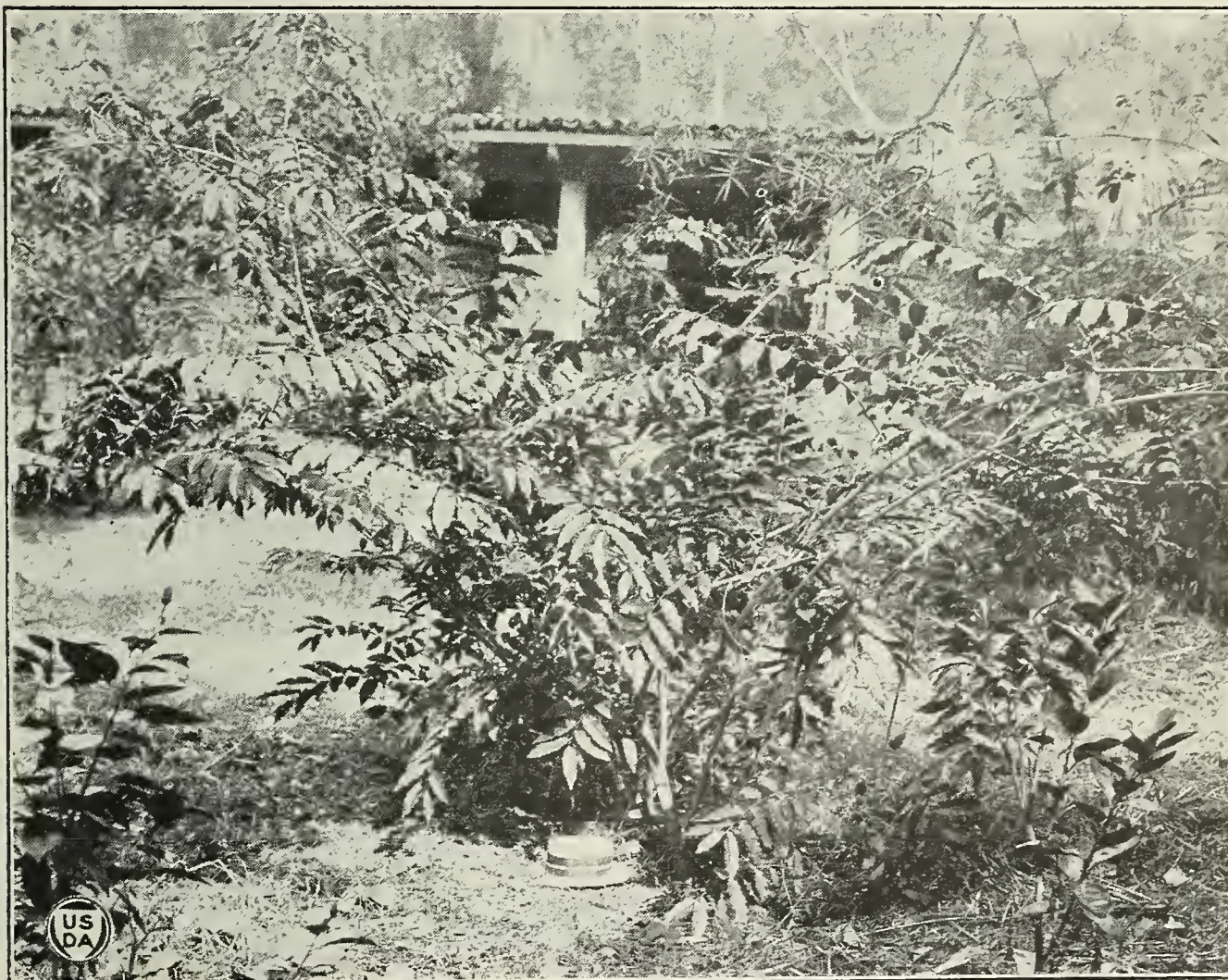


FIG. 2.—PARAGUAY TEA, RECENTLY INTRODUCED INTO PORTO RICO



FIG. 1.—COFFEE TREES ON RIGHT RECEIVED 11 OUNCES OF SULPHATE OF AMMONIA PER TREE. TREES ON LEFT, SAME PLUS 9 OUNCES OF SULPHATE OF POTASH



FIG. 2.—UNKNOWN VARIETY OF SUGAR CANE FROM JAVA, IMMUNE TO CHLOROSIS

mosaic disease, continues to make vigorous growth. The unknown variety from Java belongs to the North Indian family of canes, and is very similar to the Uba or Kavangire. It can be distinguished from the Uba, however, by its swollen internodes and by the ease with which the leaves separate from the stalk. This variety is extremely vigorous and apparently is immune to the mosaic disease. Two varieties, received from Mauritius and Barbados, have not been sufficiently tested to ascertain their merit. The variety P. O. J. 213 seems to be rather easily affected by mosaic disease.

The following table gives the Brix hydrometer reading, sucrose content, and purity of juice of first ratoon and plant cane harvests:

Composition of the juice of first ratoon and plant cane ¹

Variety	Brix reading	Sucrose	Purity
First ratoons, 11 months old:	Degrees	Per cent	Per cent
Uba.....	16.86	13.67	81.10
P. O. J. 36.....	19.04	17.18	90.25
P. O. J. 234.....	19.71	17.88	90.67
G. C. 1480.....	18.37	16.13	87.80
G. C. 1480.....	19.32	17.20	88.86
St. Croix 12/4.....	19.31	17.24	89.26
Plant cane, 16 months old:			
P. R. 260.....	17.26	13.90	80.50
P. R. 292.....	17.43	14.73	84.50
G. C. 701.....	18.09	16.11	89.05
G. C. 1313.....	16.20	12.91	79.70
G. C. 1480.....	13.83	9.52	68.80
D. 117.....	17.33	14.88	85.90
B. 4596.....	14.28	10.44	73.10
B. H. 10/12.....	18.58	16.08	86.50
P. O. J. 213.....	17.63	15.46	87.70

¹ The samples ground ranged from 30 to 90 pounds.

Bud selection experiments with the P. O. J. 36 and Uba varieties gave negative results, and were therefore discontinued.

All cane seedlings which were grown in 1919 and 1921 and became affected with mosaic disease were destroyed. Attempts were made during the winter to produce seedlings by fertilizing the arrows of Uba cane with pollen from cane varieties P. R. 292 and M. P. R. 7. No seedlings were obtained, however, the ripe arrows of cane varieties P. R. 292 and M. P. R. 7 germinated so poorly as to be considered poor pollenizing sorts. In an effort to induce seed to germinate, the station planted a number of arrows in both sterilized and unsterilized soil and in seed boxes which were covered with glass. The plantings were watered with a weak solution of sodium nitrate, which in some instances was applied through bamboo tubes reaching to the bottom of the boxes. Beneficial results were obtained in cases where the boxes were covered with glass or where sterilized soil was used. Few seed germinated, however, in cases where subsurface irrigation was practiced. This method has the disadvantage of not permitting the uniform distribution of moisture through the boxes. The following list gives the average germination per box of the different varieties: P. R. 359, 298.1; D. 109, 281.7; P. R. 492, 37; B. 1809, 33.6. The varieties B. 6450, St. Croix 12/4, M. P. R. 7, D. 216, G. C. 1480, and P. R. 358 produced less than 10 per box. The varieties P. O. J. 36, P. O. J. 105, P. O. J. 213, Uba, P. R. 292, and B. 4596 gave no germination whatever. Fully 35,177 seedlings, including those of D. 109 and P. R. 359, were produced from a total of

350 boxes of seed. Of these seedlings, only 8,237 were set in the field, the others either dying or being discarded at the time of transplanting.

WHEAT

During the summer and fall pot experiments were carried on under glass to observe the behavior of wheat under different cultural and fertilizer treatments. The results, while not very conclusive, would seem to indicate that the yield is decreased by (1) planting too deep (2 inches); (2) planting in a trench which is filled in with soil as the plants grow; (3) giving the crop an insufficient supply of water, that is, about 0.6 of an inch per week; (4) withholding water from the crop after about 10 days after heading; and (5) failing to use fertilizers. Clipping the young plants gave conflicting results. Mulching with cane trash increased the yield, regardless of whether the plants were watered at the rate of 0.6 or 0.9 of an inch per week. Adding lime to the fertilizer, withholding potash from it, or varying the amount of nitrogen in it had no appreciable effect on yield.

Each of the varieties was planted in one to fifteen 4-foot rows and tried out under irrigation during the winter. Owing to the poor stand made the yield per row could not be calculated. The Indian wheats, C. I. Nos. 4558 and 4695, however, clearly outyielded all others, as they had done in each of the three preceding tests.

TOMATOES

Approximately 1,700 tomato plants were grown during the winter, including commercial varieties, mixed stock of unknown origin, and second, third, and fourth generation hybrids. The best yielding varietal selections were obtained from Sutton's Best-of-All, Lares Native, Norton, and New Century Wilt Resistant, which produced on the average 3.1, 2.24, 2.2, and 2.04 pounds, respectively, of fruit per plant. Norton, obtained under the name Stark's Blight Resister, and Burpee's Self-Pruning were tested for the first time. Stark's Blight Resister not only proved of value in its apparently marked resistance to wilt, but it also made a fair yield of good, solid tomatoes, some of which, however, had a tendency to crack. Burpee's Self-Pruning made a poor showing, giving the lowest yield of all the varieties grown.

Crosses were made between imported and native varieties in the hope of producing strains having greater vigor than the ordinary commercial varieties but maintaining the improved type of the latter. Although some of the commercial varieties have been known to yield as much as the native sorts, the progeny averaged considerably higher in yield than either parent. As a result of these crosses the yield of fruit has increased, but there has been no marked improvement over the best varietal selections in wilt resistance. In some instances the bitter flavor of the native parents has not been entirely eliminated and in others the fruits are not as smooth and uniform as is true of the commercial varieties.

Crosses were also made between the different imported varieties in the hope of obtaining a vigorous growing, heavy yielding, wilt-resistant strain which will produce fruit of good size and shape. The progeny obtained by crossing Globe with Mack's Prolific, both of which were discarded because of their low yields, have outyielded each parent.

In order that observation might be made of their wilt-resistant ability, promising selections were grown in a plat on which several successive crops of tomatoes had succumbed to wilt. Of these, Stark's Blight Resister showed the greatest degree of resistance, only 21 per cent of the plants dying within 162 days after planting. Selection No. 105, from Insular Station Tomato No. 443, was next, three plants out of 13, or 24 per cent, dying. Two of the selections from unknown parentage showed a fair amount of resistance, while No. 5-8, the progeny of Greater Baltimore and Native, was poor, and Sutton's Best-of-All very poor.

In September a trial of tomatoes was made at an elevation of 1,000 feet on the Mesa, near Mayaguez, the varieties Norton Wilt Resistant, Globe crossed with Prolific, and Burpee's Self-Pruning being planted. A considerable number of the fruits rotted, due to infrequent harvesting, and others were bruised and mashed during the haul by oxcart to Mayaguez. Notwithstanding these losses, the total yield of sound fruit, weighed at Mayaguez, was 1,674 pounds, which was at the rate of 10.7 tons per acre.

MUSKMELONS

The fifth generation plants resulting from a cross of a large native muskmelon with Salmon Tint Pollock and with Hybrid Casaba were grown during the winter. Due to noncontrol of the pollination through several generations, the different selections are still highly variable. Apparently little progress can be made in this respect until self-pollinated or close-pollinated seed is obtained.

SWEET CLOVER

Seed of Hubam clover, produced from plants grown at the station last year (1922), was sown on a small plat November 21. Later, 22 plants were transplanted in order that they might make a uniform stand. They made thrifty growth, reaching a height of about 6 feet, and produced a good crop of seed (1 pound 8 ounces), which was ready for harvesting May 12. The weight of the dry plants was 6 pounds 10 ounces.

SWEET CORN

Sweet corn breeding work, having for its object the development of a vigorous hybrid that will be adaptable to island conditions, was continued. The F_3 hybrids are more vigorous than the parents, and the F_4 ears of the hybrid under test show some improvement over the sweet corn introduced from the States.

REPORT OF THE ENTOMOLOGIST

By W. V. TOWER

FUMIGATION EXPERIMENTS FOR THE CONTROL OF THE CIGARETTE BEETLE

The entomologist spent three months of the year in fumigating the warehouses and factories of the largest tobacco company in Porto Rico. Cigars and stored tobacco had become so generally infested

with the cigarette beetle (*Lasioderma serricornis*) that all buildings in which tobacco is handled in the process of manufacture, including all workrooms, had to be fumigated. Fully 4,750,000 cubic feet of space was fumigated. The warehouses were treated with 40 ounces of sodium cyanid per 1,000 cubic feet for 48 hours.

The entomologist also assisted a continental concern in demonstrating the use of liquid hydrocyanic acid as a fumigant in two warehouses, both piped with one-fourth inch black iron pipes. In one of the warehouses, which is 200 by 60 by 16 feet, the following plan was carried out: Pipes were run lengthwise through the center of the building to the outer walls where they were connected with solution tanks. The pipe lines were raised about 9 feet from the floor and carried 6 or 7 spray nozzles that were directed toward the floor. When all was ready, the liquid was pumped under pressure into the pipes and evenly distributed through the building, being expelled through the spray nozzles in a mist which immediately turned to gas.

The operator must be as careful when handling tanks of liquid hydrocyanic acid as when fumigating by the pot or barrel method. Liquid hydrocyanic acid is twice as powerful as solid cyanid or cyanid solution, and will certainly cause trouble if the pipes leak. Considerable time is required to charge the machine in the liquid hydrocyanic-acid method, but reckoning, weighing, handling of the material, and having to dispose of the residue, are dispensed with. The operator should not only wear gloves to protect his hands from painful burns, but he should also be provided with a gas mask in case of emergency. Commercial concerns should permit fumigation to be done only by a thoroughly efficient operator, such as a chemist, entomologist, or other person who is acquainted with the nature of poisons.

The method used for fumigating baled tobacco can also be used for Porto Rican cigars which have been packed for shipment. The gas penetrates the cigars and kills any insects present, regardless of their stage of development. Owing to the relatively humid air of Porto Rico, fresh cigars should be aired for three or four weeks, and others longer, after being fumigated.

Fumigation was started about the middle of February, and although the work was not completed until about the first of June, losses due to returned cigars began to decrease in April. The April statement from the New York receiving house to the San Juan office showed a saving of 40 per cent over previous losses occurring in May and June (75 per cent each). At the receiving house it was thought that a great proportion of the remaining 25 per cent loss was on old stock which had not been fumigated. It is also possible that the cigars became reinfested in the New York storage terminal.

The New York house was not alone in reporting a decrease in loss. Selecting and inspecting room managers formerly had to discard as many as 10,000 wormy cigars in some months, and to employ a large force to examine every box, cigar by cigar, in which a wormy cigar was found. By fumigating their houses, tobacco companies have been enabled to cut expenses appreciably. Very few wormy cigars are now found in the factories.

CITRUS SCAB, SCALE, AND INSECTS

The winter and spring months had a marked influence on the presence of scab. The long rainy season was followed by the worst period of drought Porto Rico has experienced in years. Some districts suffered more than others. In many instances, the rain interfered with spraying programs, and the required number of applications could not be made. One of the largest local growers, who obtained excellent results in the cooperative scab control experiment conducted in 1922, sprayed his whole plantation of 4,000 trees. He could not carry out the program as planned, however, because of adverse weather conditions, and his present crop is not as clean as was that of 1922.

During the dry period many growers could not clean up the scale that always follows sprayings with Bordeaux-oil emulsion. Both the purple scale and the rufous scale severely attacked the fruit in some of the plantations where the trees had been sprayed with the emulsion.

Rust mites and red spiders are very troublesome in citrus groves after the trees have been sprayed with Bordeaux-oil emulsion. When lime-sulphur is used following the emulsion, the leaves and fruit become covered with a reddish-brown precipitate, which gradually disappears, or is washed off as the fruit passes through the brushes in the packing houses.

COTTON INSECTS

In December, 1922, hundreds of acres of cotton in the Cabo Rojo district were destroyed by cutworms and a species of caterpillar (*Alabama argillacea*). At the time the entomologist visited the district, caterpillars were crawling over everything, all trees and bushes being covered with them. This section is very dry during the greater part of the year. Large salt works occur along the coast, but there is a very fertile sandy loam back of the beaches. Fine crops of cotton and corn are produced when there is a little rain.

If spraying is undertaken for control, it should be done as early in the morning as possible before the heavy breeze begins to blow, which is about 10 o'clock. Dusting as a method of control does not seem practicable, because of the absence of dew and the presence of heavy winds. Good results were obtained from the use of poison bait.

VEGETABLE AND FLOWER INSECTS

From time to time the entomologist is called upon to prepare spraying solutions for various members of the station staff who are working with vegetables and flowers. Sweet corn, which has not as yet been successfully grown in Porto Rico, was repeatedly sprayed with nicotine sulphate (5 cubic centimeters of the sulphate to 1 ounce of soap) to kill the lice, leaf hoppers, caterpillars, and other insects feeding upon it. The treatment effectively held the pests in check, but had no repellent qualities. In some instances, as high as 15 cubic centimeters of nicotine sulphate was sprayed without burning the plants. Striped cucumber beetles (*Diabrotica innuba* and *D. bivit-*

zeta), which attacked casaba melons, cucumbers, and watermelons during the winter months, were brought under control by the use of a spray made with Bordeaux (2-3-50) and arsenate of lead (1½ pounds). The striped cucumber beetle was present in great numbers in the soy bean experimental plats during the summer months, and nematodes caused serious losses in truck gardens, attacking celery, beets, carrots, peppers, tomatoes, eggplants, dahlias, dracenas, and melons. Plant lice were found on dahlias and zinnias.

STORAGE OF GRAPEFRUIT

For the last three years the entomologist has been trying to determine the best method of storing grapefruit for home use. The fruit has been found to keep for a short time, say two or three months, in dry sand, sawdust, or coconut fiber, and for a longer period in moist sea sand or clear river sand, moist sawdust, or moist coconut fiber. The fruit should be thoroughly cleansed of scale before storing, otherwise it will break down as the scale increases. Two weeks after the fruit has been placed in storage it should be looked over carefully and the decayed specimens removed. In many instances, few decayed fruits were found in lots of grapefruit that had been stored three and four months. The longest period of storage was 14 months, but losses began to occur after the fifth month. The varieties showed little difference in keeping qualities when the matured fruit was stored. Of the lots tried, Pernambuco had the best keeping qualities, with Marsh Seedless ranking second and Duncan third.

In order that the best results may be obtained, the fruit should be picked when it has reached its prime. This is true especially concerning the Marsh Seedless, the seeds of which will sprout soon after the mature fruit is placed in storage. The Duncan variety, when fully mature, seems to hold up better than does the Marsh Seedless, the flesh retaining its normal color and fine eating qualities, and seeds not sprouting so quickly. Fine-skinned fruits were found to remain in good condition longer than those with coarse skin. Sprouting seeds are often found in fruit which remains too long on the tree, say from 14 to 16 months, and the seed of mature fruit sometimes sprouts after a rain follows a long drought.

Clean, moist sand or sawdust is probably the best material in which to store grapefruit for home use. Dry sand may be used, but fruit shrinks when stored in it a short time. Storing grapefruit for short periods in dark, moist chambers gave satisfactory results, the fruit not shrinking for two or three months. Shrinking occurred when the fruit was stored for six months in the open in moist chambers, but not when it was stored for the same length of time in moist coconut fiber in moist chambers. Heavy losses, due to sun and rain, occurred in about 500 grapefruits which were stored in coconut fiber in the open, and at the end of three weeks a lot of 30 cases of loose oranges showed a decay of 66 per cent when stored in coconut fiber in the open.

Cockroaches, which considerably damage stored fruit, may be held in check by the use of roach pastes. Grapefruit when stored should be well protected from rats.

MISCELLANEOUS

The giant toad (*Bufo aqua*), which was introduced into Porto Rico several years ago, is rapidly increasing in number in this part of the island, and will doubtless assist in lessening certain of the insect pests. Horned lizards and horned toads, which were released in the dry lands of southwestern Porto Rico, have not as yet been seen in this section.

REPORT OF THE PLANT PATHOLOGIST

By C. M. TUCKER

Since his appointment in June, 1923, the plant pathologist has spent the major part of his time in planning and preparing for various lines of investigation which are to be undertaken. The entire collection in the herbarium was card-indexed, and some additions were made to it.

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A BROWN SPOT DISEASE OF RICE (*Helminthosporium* sp.)

Experiments are being continued for the control of seedling blight of rice, due to a fungus (*Helminthosporium* sp.), both hot water and chemical seed treatments being used. A study is being made of the possibility of soil infection, insects as disseminating agents, and of varietal resistance.

A ROOT DISEASE OF VANILLA

Vanilla, recently introduced into Porto Rico, gives promise of becoming a paying crop in certain sections well adapted to it. The original vanilla planting at the station was destroyed by a root disease which is proving a menace to the industry elsewhere on the island. Numerous examinations of the organism from infected roots, obtained from three different plantings, showed it to be the same fungus (*Fusarium* sp.). Pure cultures were isolated and used to inoculate potted plants that are growing in sterilized coconut fiber. Both pots and plants are covered with cheesecloth. Another series of inoculation experiments was made with plants which are growing in large glass tubes of sterilized fiber.

The old vanillery was selected as an ideal place in which to test the fungicides for use in controlling the disease in an infected soil. The supporting trees (*Erythrina corallodendron*) were thoroughly cleansed by scraping all adhering vanilla roots from them and by washing the trunks and main branches with Bordeaux mixture (5-5-50). Disinfectants were applied to the soil and organic matter was placed about the base of the trees. The disinfectants included carbolineum, copper sulphate, chlorid of lime, formaldehyde, sulphuric acid, paradichlorbenzol, lime, and Bordeaux mixture. Cuttings were then planted, and some of them were given applications of lime or Bordeaux mixture at certain intervals.

Laboratory work will be undertaken as soon as the causal organism is definitely established, to determine its resistance to various chemicals and to test its pathogenicity to other plants.

BANANA WILT

Since 1916 a plat of Chamaluco bananas, the soil of which is thoroughly infected with the banana wilt, or Panama disease, organism (*Fusarium cubense*), has been under observation for the selection of resistant plants and the production of an immune or resistant strain. So far the results have not been encouraging. The plants were recently cultivated and each was given an application of 2 pounds of a 6-8-10 fertilizer.

A *Fusarium* which seems identical with that mentioned above was obtained from a diseased pseudostem of plantain which was recently received from Fajardo, in the eastern part of the island. Porto Rican banana growers are of the opinion that most varieties of bananas are susceptible to wilt in varying degrees. Plans are being made to determine the pathogenicity of the fungus to some of the most commonly grown varieties.

SCAB-RESISTANT GRAPEFRUIT

An experiment, undertaken for the production of a scab-resistant variety, was turned over to the plant pathologist by the assistant plant breeder. The seedlings resulting from a cross between Duncan, a commercially valuable variety, and Triumph, a relatively scab-resistant variety, are now about three years old. When carefully examined in October for evidence of scab infection on the young leaves and stems, 48 trees were found to be heavily infected, 89 slightly infected, and 187 free from infection.

Climatic conditions at the station differ from those obtaining in the principal citrus sections of the island. At Mayaguez the rainy season is coincident with the season of highest temperatures. Along the northern coast in the citrus region the rainfall is rather heavy in the early spring, while the temperature is comparatively low, creating ideal conditions for scab infection.

Individual records are being kept for each seedling, and those showing continued resistance to scab will be budded on rough lemon stock in some location that is favorable to infection for further trial of resistant strains.

REPORT OF THE SPECIALIST IN FARM MANAGEMENT

By H. C. HENRICKSEN

The principal lines of investigation conducted by this division during the year included studies of some of the critical factors governing pineapple production, the shipping and keeping qualities of pineapples, artificial coloring of citrus fruit, changes taking place in precooled citrus and pineapple fruit, and the marketing of onions.

PINEAPPLES

Pineapple-production investigations have not advanced sufficiently to permit of the publication of a report at this time, but the work is progressing favorably and the results are very promising. Plants

were grown in water and sand cultures to which different chemicals were added, and potted plants were grown in soils that were taken from pineapple fields where the crop showed certain characteristics. The pot culture experiments yielded more valuable data than did those conducted in the field from which the soils were taken.

Results of a study made to determine the rate at which the pineapple matures when it is kept at various temperatures, and likewise of the maturity changes occurring after refrigeration, showed that a temperature ranging from 50° to 60° F. for one week will partly arrest maturity changes, and that even plant-ripened fruit may be kept at this temperature for the same length of time with little change, unless, of course, it is infected with fungi. Green fruit will not perceptibly change color when it is kept at the above-mentioned temperature. A temperature ranging from 35° to 40° F. will arrest maturity changes considerably, regardless of whether the fruit is ripe or green. When very green fruit is kept in storage for 6 days only, it will mature upon removal from refrigeration. The fruit will not show normal change in either color or composition, however, if it is kept for a period longer than 6 days in a room where the temperature ranges from 35° to 40° F. In other words, pineapples which are precooled for a short period at a temperature as low as 35° F. will ripen normally upon being removed from refrigeration; and fruit that has fully ripened can be stored for some time at a temperature of about 40° F.

In connection with a study of the effect of temperature on shrinkage, it was found that fruit shrunk very little when well packed and kept for 6 to 10 days in a room where the temperature ranged from 35° to 40° F. Of the various protective measures against shrinkage, that of covering the fruit with paraffin gave the most satisfaction under certain conditions. The paraffin was kept several degrees above the melting point. The fruit was dipped up to the crown, and then held over the boiler to allow the excess paraffin to drip off. Green and bronze-colored fruit should not be covered with paraffin since it hinders subsequent color changes. Large, fancy, plant-ripened fruit, such as is suitable for window display, may be paraffined, as it will show to better advantage and keep in good condition longer than will unprotected fruit.

CITRUS FRUITS

Inasmuch as the price of citrus fruit is largely determined by its appearance, the color is naturally of great importance. The problem of artificially coloring fruit was attacked at the beginning of the shipping season. Further investigation along this line will be made as soon as time permits.

Shippers and carriers have manifested considerable interest this year in the question of precooling fruits. In order to ascertain the temperature which will arrest stem-end rot of oranges and grapefruit, 5 lots of fruit were kept for 5 days at temperatures ranging from 35° to 80° F. The results confirmed those of experiments mentioned in a former report.² It was found that stem-end rot can

² Porto Rico Sta. Rpt. 1920, pp. 27-36.

be arrested by cooling the fruit immediately after it is packed, and by keeping it at a temperature of about 45° F. Although infected fruit can be kept at this temperature without decaying, it will rapidly decay as soon as it is removed from the refrigerator.

In order to determine whether precooling can be used to advantage when fruit is to be shipped on nonrefrigerated steamers, 500 boxes of fruit were cooled to 50° F. and then stowed in a compartment of a nonrefrigerated steamer. As a result of observations made of the changes taking place en route and the condition of the fruit upon its arrival in New York, it was concluded that fruit should be cooled to a temperature of between 35° and 40° F. and transferred directly from the refrigerator to an insulated hold of the steamer. The hold should be filled, and likewise provided with ventilation to permit of the removal of moisture and carbon dioxide. When these precautions are taken the temperature of the hold will hardly rise above 60° F. during the trip from Porto Rico to New York.

ONIONS

Although the Bermuda onion is produced in Porto Rico in commercial quantities, its cultivation is not very remunerative, because the crop is not exported and the supply is greater than the demand. The writer therefore made a study of the market conditions in New York while he was there in connection with the precooling experiments previously mentioned. The data obtained show that for many years the price of Bermuda onions has been high in March. Growers are urged to use the best seed obtainable, plant for early maturity, and use standard field and packing methods in order that they may market the crop at remunerative prices.



